CHAPTER 6 - TEMPERATURE AND DEW POINT

6.1 Introduction

This chapter describes observing, determining, and reporting the temperature and dew point temperature in a surface observation. The temperature data obtained using the instruments in this chapter are in terms of the Celsius scale. Dew points are calculated with respect to water at all temperatures.

6.2. Temperatures

a. Dew Point. The temperature at which a parcel of air becomes saturated when cooled at constant pressure and constant water-vapor content.

b. Dry-bulb. Technically, the ambient temperature registered by the dry-bulb thermometer of a psychrometer. However, it is identical to the temperature of the air and may also be used in that sense.

c. Wet-bulb. The lowest temperature attained by evaporating water from a saturated wick covering the bulb of a thermometer at the point of observation.

6.2.1 Hygrothermometer

An instrument system using remote sensors to obtain ambient air and dew-point temperatures. Digital or dial readouts show temperatures.

6.2.2 Instrument Shelter

A boxlike structure designed to protect thermometers from exposure to direct sunshine, precipitation, and condensation, while at the same time providing adequate ventilation.

6.2.3 Psychrometer

An instrument used for measuring the water-vapor content of the air. It consists of two ordinary glass thermometers. The bulb of one thermometer (wet-bulb) is covered with a clean muslin wick, which is saturated with water prior to an observation. When the bulbs are properly ventilated, they indicate the wet- and dry-bulb temperatures of the atmosphere.

6.2.4 Psychrometric Calculator

A circular slide rule used to compute the temperature of the dew point from known values of dry- and wet-bulb temperatures at the station's normal atmospheric pressure. Instructions for the use of this calculator are printed on it.

6.2.5 Psychrometric Tables

Tables prepared from a psychrometric formula and used to obtain the temperature of the dew point from known values of dry- and wet-bulb temperatures.

6.2.6 Sling Psychrometer

A psychrometer that is ventilated by whirling the thermometers with a handle and a swivel link until the coldest wet-bulb temperature has been obtained.

6.2.7 Wet-bulb Depression

The difference between the dry- and wet-bulb temperatures. Example:

Dry-bulb	Wet-bulb	Wet-bulb Depression
33.8	23.5	10.3
)6.7	)7.4	0.7

6.3 Obtaining Psychrometric Data

The method of obtaining temperature and dew point values varies with the system in use at your station.

When the dew point temperature from the system in use equals or exceeds the dry-bulb temperature and the system is within operational limits:

a. Assume the wet-bulb and dew-point temperatures with respect to water to be the same as the dry-bulb temperature if the wick of the wet bulb is not frozen or liquid fog is present, or

b. Assume the wet-bulb and dew-point temperatures with respect to ice to be the same as the dry-bulb and convert them to their water equivalent if the wet-bulb wick is frozen or ice fog is present.

6.3.1 Hygrothermometer Readings

If temperature readings are within the operating range of the hygrothermometer, obtain data in accordance with the following:

a. If readings are obtained from dial indicators, face each indicator on as direct a line of sight as possible to minimize parallax errors.

b. Observe temperatures to the nearest degree Celsius. If readouts are in Fahrenheit, use Fahrenheit-to-Celsius conversion chart.

c. If the temperature is –34.4°C (–30°F) or lower, disregard the dew point indicated on the instrument and assume the temperature of the dew point to be the same as the temperature (dry-bulb) with respect

to ice. Convert it to the corresponding dew point with respect to water using a psychrometric calculator.

6.3.2 Hygrothermometer to Station's Standby Equipment

Obtain psychrometric data from your station's standby equipment whenever the following occur in relation to your station's hygrothermometer:

a. If readings exceed the operating range of the hygrothermometer.

b. If the difference between the ambient air temperature and the hygrothermometer exceeds 2°F.

c. If the dew point is higher than the dry-bulb temperature or if the comparison checks indicate that the sensor is out of calibration. Discontinue use of the sensor until it has been serviced and calibrated.

6.3.3 Psychrometer Operating Procedures

Obtain readings from dry-bulb and wet-bulb thermometers using the following instructions.

6.3.3.1 Dry-bulb Thermometer

When driving rain or snow is occurring, dry the bulb and shield it from the precipitation as long as necessary to permit dissipation of extraneous heat before reading it again. Use this reading for psychrometric purposes rather than the reading normally made when the lowest wet-bulb reading is taken. When frost forms on the thermometer, remove it with a warm cloth and allow sufficient time for the dissipation of extraneous heat before reading the thermometer.

6.3.3.2 Wet-bulb Thermometer

The procedure used in moistening the wet-bulb varies according to whether the dry-bulb temperature is above, near, or below freezing, and whether the relative humidity is high or low, as described below.

6.3.3.3 Temperature Above Freezing

Moisten the wet-bulb with clean water just prior to ventilating the psychrometer (even if the humidity is high or the wick already appears wet). If, however, the temperature is high and the relative humidity is low, or it is expected that the final temperature of the wet-bulb will be 32 degrees or less, moisten the wet-bulb thoroughly several minutes before taking a reading so that a drop of water will have formed on the end of the bulb. This procedure will reduce the temperature of the wet-bulb without danger of the wick drying out before the temperature reaches its lowest point.

6.3.3.4 High Temperature and Low Humidity

In areas where the temperature is high and the relative humidity low, use pre-cooled water for moistening the wet-bulb to avert premature drying of the wick. Water can be pre-cooled for this purpose by storing it in a

porous jug. To avoid altering moisture conditions in the shelter, do not keep this jug in the shelter. If this method should not be effective, extend the wick from the wet-bulb to an open container of water and keep the end of the wick immersed in water between observations. When the psychrometer is ventilated, remove the wick from the water until the wet-bulb thermometer has been read. Regardless of the method used, ventilate the psychrometer in accordance with 6.3.3.7 before determining the wet-bulb temperature.

6.3.3.5 Temperatures Below Freezing

At wet-bulb temperatures below 32°F, if the wick is not frozen, touch it with clean ice, snow, or another cold object to induce freezing. If the observer is unable to induce freezing of the wick, use the low temperature range of the psychrometric calculator for the computation of psychrometric data.

6.3.3.6 Dry-bulb Temperature Below 37 Degrees Fahrenheit

At dry-bulb temperatures of 37°F or below, use water that has been kept at room temperature in order to melt completely any accumulation of ice on the wet-bulb. Moisten the bulb thoroughly, at least 15 minutes before ventilating the psychrometer to permit the latent heat to be released if the water freezes and to be dissipated before ventilation is begun. Do not allow excess water to remain on the wet-bulb, since a thin, thoroughly cooled coating is necessary for accurate data.

6.3.3.7 Psychrometric Ventilation

Ventilate the psychrometer for about 10 seconds. The minimum speed of air passing over the psychrometer bulbs should be 15 feet per second. This is approximately one revolution per second of the geared (2-to-1 ratio) whirling psychrometer crank, two revolutions per second of the sling psychrometer, and three and one-half revolutions per second of the crank of the psychrometer fan or motor (direct-drive) whirling psychrometer.

6.3.3.8 Sling Psychrometer Ventilation

Ventilate the sling psychrometer as follows:

a. Select a shady spot with no obstructions within a radius of the whirling sling.

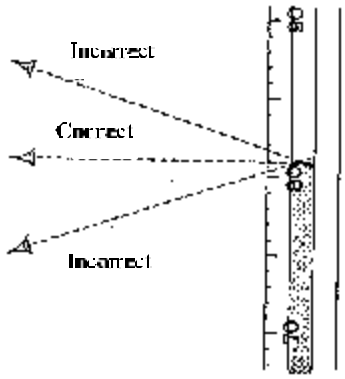
b. Face into the wind.

c. Hold the handle at arm's length while whirling the psychrometer.

6.3.3.8.1 Reading Liquid-in-Glass Thermometers

Observe the temperature from mercury- or alcohol-in-glass thermometers as follows:

The observer shall stand as far from the thermometer as possible to prevent body heat from affecting the readings. To minimize errors of parallax, make sure that the line of sight from your eye to the top if the liquid column is level. Read the dry- and wet-bulb temperatures to the nearest tenth (0.1) of a degree.



6.3.3.8.2 Psychrometric Evaluations

a. Near Freezing Temperature. At wet-bulb temperatures near freezing, determine visually that the wet-bulb is unfrozen before using wet-bulb depression data.

b. Unobtainable Depression. When the wet-bulb is covered with water and a depression cannot be obtained, the relative humidity shall be regarded as 100% and the temperature of the dew point the same as that of the wet-bulb. If the wet-bulb is covered with ice and a depression cannot be obtained, use the dew-point converted to the equivalent value with respect to water, unless liquid fog is present at the station. In this latter instance, the dew point will be regarded as the same as the wet-bulb temperature.

6.3.3.9 Obtaining Readings

After proper ventilation has been achieved, quickly read both thermometers, wet-bulb first. Repeat until two successive wet-bulb readings are the same, indicating that the wet-bulb temperature has reached its proper point. If the wet-bulb temperature rises between successive readings, pre-moisten the wick and re-ventilate. Accurate readings are especially important at low temperatures, where a given wet-bulb depression has a greater effect on the accuracy of psychrometric computations.

6.3.3.10 Psychrometric Computations

Use the dry-bulb and wet-bulb temperatures to calculate the dew point with psychrometric calculators or psychrometric tables based on atmospheric pressures of 23, 25, 27, 28, 29, or 30 inches of mercury. Use a psychrometric calculator with the appropriate range, if one is available, in preference to tables.

Use the appropriate psychrometric calculator to convert dew-point values with respect to ice to a corresponding value over water. On the low-temperature face of the calculator, equivalent values of dew point appear opposite

each other on the "**DP**" (or "**t_w, DP**") and "**T_i**" scale, e.g., a dew point of 20°F with respect to ice is equivalent to 18.5°F with respect to water.

6.4 Using the Sling Psychrometer

a. If the dry-bulb temperature is above 37°F:

1. Moisten the wick of the wet-bulb thermometer with clean water. When the humidity is very low, use pre-cooled water for moistening the wet-bulb to avert premature drying of the wick.

2. Standing as far from the psychrometer as practical, ventilate it by means of the fan, whirling apparatus, or sling for approximately 10 seconds.

3. Read the wet-bulb temperature to the nearest 0.1° and make a mental note of the reading.

4. Repeat steps 2 and 3 until the lowest wet-bulb reading (indicated by two successive readings of the same value) is obtained. At this time read both thermometers then convert to degrees Celsius to the nearest 0.1°C.

5. Record the dry- and wet-bulb temperatures in columns 19 and 20 on MF1M-10.

6. Obtain the difference between the dry- and wet-bulb temperatures. Use this difference and the wet-bulb to compute the dew point on the psychrometric calculator.

b. If the dry-bulb temperature is 37°F or less:

1. At least 15 minutes before determining the wet-bulb temperature, immerse the wick into water that has been kept at room temperature. Remove any excess water from the wet-bulb.

2. At observation time, stand as far from the psychrometer as practical and ventilate it by means of the fan, whirling apparatus, or sling for approximately 10 seconds.

3. Read the wet-bulb temperature to the nearest 0.1° and make a mental note of the reading.

4. If the wet-bulb temperature is less than 32°F, examine the wick. If the wick is not obviously frozen, touch it with clean ice or some other cold object to cause ice to form on it.

5. Repeat steps 2 and 3 until the lowest wet-bulb reading (indicated by two successive readings of the same value) is obtained. At this time read both thermometers then convert to degrees Celsius to the nearest 0.1°C.

6. Record the dry- and wet-bulb temperatures in columns 19 and 20 on MF1M-10.

7. Obtain the difference between the dry- and wet-bulb temperatures. Use this difference and the wet-bulb to compute the dew point on the psychrometric calculator.

6.4.1 Computing the Dew Point

After you have determined the dry- and wet-bulb temperatures, compute the dew point with a psychrometeric calculator, a dew point table, or a psychrometic table.

To compute the dew point using a dew point table, locate at the top of the column the reading corresponding to the wet-bulb temperature. Locate at the left side of the table the reading corresponding to the dry-bulb temperature. Follow down the column under the wet-bulb temperature, and across from the dry-bulb temperature; at the intersection of these two columns will be found the dew point.

Instructions for using the calculator are printed on it. Note that different temperatures scales of the calculator will be used depending on whether the wet-bulb is covered with ice or water at the time of observation. When the wet-bulb temperature is 32°F or more, use the high range of the calculator. When the wet-bulb temperature is less than 32°F use the low range, printed on the reverse side of the calculator.

To compute the dew point using a psychrometric calculator first determine the wet-bulb depression. This is the difference between the wet-bulb and dry-bulb temperatures to the nearest 0.1°F; e.g., a dry-bulb temperature of 2.3°F and a wet-bulb temperature of –1.3°F give a depression of 3.6°F.

Other examples of determining wet-bulb depression:

Dry-Bulb	- Wet-Bulb	= Depression
75.6	58.3	17.3
38.2	37.8	0.4
4.3	–1.2	5.5
–8.7	–10.2	1.5

Use the wet-bulb temperature and the wet-bulb depression to obtain the dew point. After obtaining the depression, ignore the dry-bulb temperature. Do not make the common mistake of using the dry-bulb temperature in calculating the dew point.

Computing dew point using the high range scale:
(Dry-Bulb = 85.7°F) - (Wet-Bulb = 70.6°F) = (Depression = 15.1°F)

1. Align the "0" index of the "D" scale with the wet-bulb reading on the "DP" scale = 70.6°F
2. Align the cursor with the wet-bulb depression using the nearest station pressure ring of the "D" scale = 15.1
3. Follow the cursor out to the "DP" scale and read the dew point temperature: P=30 = 63.2°F converted to Celsius = 17.3°C; entered in column 12 as 17.

Computing dew point using the low range scale: Frozen Wick
(Dry-Bulb = 30.1°F) - (Wet-Bulb = 27.8°F) = (Depression = 2.3°F)

1. Align the "0" index of the "D" scale with the wet-bulb reading on the "Ti" scale (inner temperature ring) = 27.8°F

2. Align the cursor with the wet-bulb depression using the nearest station pressure ring of the "D" scale = 2.3

3. Follow the cursor out to the "DP" scale (outer temperature ring) and read the dew point temperature: P=30 = 22.8°F converted to Celsius = –5.1; entered in column 12 as –05.

Computing dew point using the low range scale: Unfrozen Wick
(Dry-Bulb = 32.4°F) - (Wet-Bulb = 29.1°F) = (Depression = 3.3°F)

1. Align the "0" index of the "D" scale with the wet-bulb reading on the "DP" scale (outer temperature ring) = 29.1°F

2. Align the cursor with the wet-bulb depression using the nearest station pressure ring of the "D" scale = 3.3

3. Follow the cursor out to the "DP" scale (outer temperature ring) and read the dew point temperature: P=30 = 23.0°F converted to Celsius = –5.0; entered in column 12 as –05.

Both the tables and psychrometric calculator are designed to give you the dew point with respect to water, which is the value always reported in the aviation weather observation. The dew point can also be determined with respect to ice, but this will concern you only if:

1. The wick of the wet-bulb is covered with ice and you cannot get a depression (the dry- and wet-bulb readings are the same),

2. Freezing Fog (FZFG) is present.

When the wick is covered with ice and you are unable to get a depression, consider the dew point with respect to ice to be the same as the dry-bulb temperature and convert it to the dew point with respect to water. However, if this condition exists and Fog (not freezing fog) is present, assume the dew point with respect to water to be the same as the dry-bulb temperature. Whenever Freezing Fog is present, assume that the dew point with respect to ice is the same as the dry-bulb temperature, and convert it to the dew point with respect to water. If the temperature is –30°F or below, there is no need to determine the wet-bulb temperature.

The conversion from ice to water can be made easily with the psychrometric calculator. Find the dew point with respect to ice on the T_i scale (A in Figure 6-1) and then read the dew point with respect to water directly opposite it on the DP (or Tw,DP) scale (B in Figure 6-1).

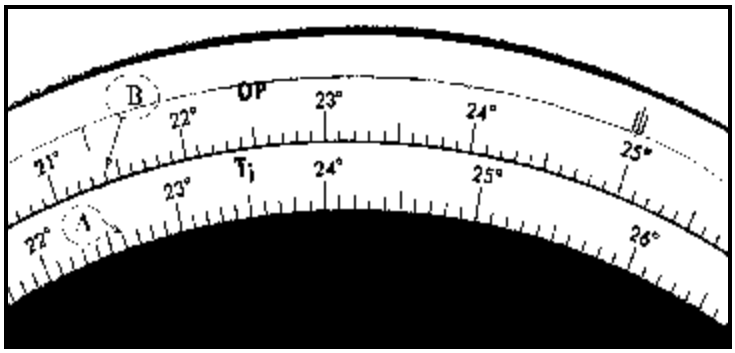


Figure 6-1. Conversion of Dew Point.

As a check on dew-point calculations, remember that the dew point will always be equal to or less than the dry-bulb and wet-bulb temperatures. If the dry- and wet-bulb temperatures are the same, the dew point will also be the same unless the conversion from ice to water is involved.

6.5 MF1M-10C Reporting Procedures

If temperature data were obtained with the use of Fahrenheit instruments, conversion to Celsius shall be made before temperature data are recorded on MF1M-10C. Determine and report dry-bulb and dew-point temperatures for each METAR/SPECI report.

6.5.1 Temperature (Column 11)

Record temperature to the nearest whole degree Celsius. Prefix sub-zero Celsius temperatures with a minus sign (–). A leading zero is attached to single digit temperatures.

6.5.2 Dew-Point Temperature (Column 12)

Record the dew-point temperature to the nearest whole degree Celsius. Prefix sub-zero Celsius temperatures with a minus sign (–). A leading zero is attached to single digit temperatures. The dew-point entry is included if needed for terminal forecasts.

6.5.3 Dry-Bulb and Wet-Bulb Temperatures (Columns 19 and 20)

These columns are completed only if they are used to compute dew point; i.e., when a psychrometer is used. Enter data in degrees and tenths Celsius. Prefix sub-zero temperatures with a minus sign (–).

6.6 Coding Procedures

While both Temperature and Dew Point are determined to the nearest tenth of a degree Celsius they shall be reported in the body to the nearest whole degrees Celsius.

The temperature and dew point are considered to be a single group separated by a solidus ("/"). In the transmitted coded report sub-zero temperatures are preceded with the letter "M" instead of a minus sign. If the dew point is not reported or is missing, the "/" still follows the temperature. You can report a temperature and have a missing dew point, but you cannot report a dew point and have a missing temperature. If the temperature is missing, the group is omitted from the report.

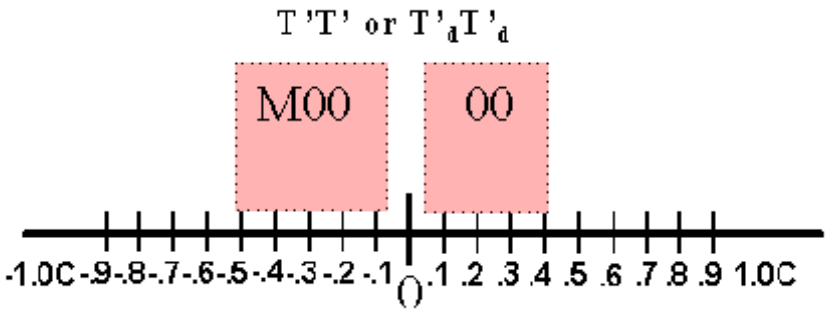
Example: M20/

Question: Will a minus zero (M00) ever be recorded?

Answer: Yes!

If your temperature or dew point read from 31.1 to 31.9 degrees Fahrenheit, which is equivalent to minus 0.5 to minus 0.1 degrees Celsius the temperature or dew point would be coded M00.

Though the reading would be rounded up to zero, the M (for minus) would show to what side of zero, the tenth value fell.



Examples: Temperature =31.7°F = –0.2°C Dew Point = 31.2°F = –0.4°C

Coded: M00/M00

Temperature = 32.3°F = 0.2°C Dew Point = 31.1°F = –0.5°C

Coded: 00/M00

An observer who is using Fahrenheit thermometers to obtain temperatures must convert to Celsius, but needs to read the Fahrenheit thermometers to the nearest tenth of a degree, then convert to the nearest tenth of a degree Celsius.

The rule for rounding negative numbers applies when dealing with temperatures . If the fractional part to be dropped is greater than one-half, the preceding digit shall be decreased by one. In all other cases, the preceding digit shall remain unchanged. For example, –1.5 becomes –1, –2.6 becomes –3, –0.5 becomes 0.

6.6.1 Difference Between Coded Report and MF1M-10 Entries

"M" precedes all temperatures below 0°C on the transmitted report.

"–" precedes all temperature below 0°C on entries made in columns 11 (TEMP) and 12 (DEW POINT) of MF1M-10.

Example: Transmitted: M20/M22 Columns 11 and 12:

–20	–22

Sub-zero temperatures recorded in columns 19 (Dry-bulb) and 20 (Wet-bulb) are prefixed with a minus sign (–).

SKY CONDITION (10)	TEMP. (°C) (11)	DEW POINT (°C) (12)	ALTIMETER SETTING *(Ins.)* (13)	REMARKS AND SUPPLEMENTAL CODED DATA (14)	TOTAL SKY COVER (0-8) (17)	TEMP. DRY BULB (0.1°C) (19)	TEMP. WET BULB (0.1°C) (20)	STATION PRESSURE (Ins.) (22)	Observer's Initials (15)
	35	***14***				***35.2***	***21.3***		
	02	***-01***				***1.7***	***0.3***		
	00	***-03***				***0.1***	***-1.2***		
	-38					***-37.8***			
	-19	***-22***				***-18.8***	***-18.9***		
	-00	***-02***				***-0.5***	***-0.9***		

TEMPERATURE

DEW POINT

DRY-BULB TEMPERATURE

WET-BULB TEMPERATURE

Make entries using two digits rounded to the nearest whole degree Celsius. Prefix sub-zero temperatures with a minus sign. Add a leading zero to single digit temperatures.

Make entries in these columns, to the nearest 0.1° Celsius only if dry- and wet-bulb temperatures are used to compute the dew point. Prefix sub-zero temperatures with a minus sign. Omit the entry in column 20 if the dry-bulb temperature is –30° F or below.

If a hygrothermometer is used to obtain the dew point, don't make entries in either column.

REVIEW QUESTIONS

1. In a METAR report, the temperature/dew point group follows the _____ group.

    a. wind
    b. temperature
    c. sky condition
    d. pressure

2. Which character is used to separate the temperature and dew point?

    a. one space
    b. /
    c. \
    d. &

3. If the temperature is missing, the group is _____ .

    a. omitted
    b. replaced with “M”
    c. replaced with “MISSING”
    d. replaced with “?”

4. Temperature is determined to the nearest _____ .

    a. whole degree Fahrenheit.
    b. whole degree Celsius.
    c. tenth of a degree Celsius.
    d. tenth of a degree Fahrenheit.

5. If required, dew point is determined to the nearest _____ .

    a. whole degree Fahrenheit.
    b. whole degree Celsius.
    c. tenth of a degree Celsius.
    d. tenth of a degree Fahrenheit.

6. Temperature and dew point are reported in the body of the METAR/SPECI report in _____ .

    a. whole degrees Fahrenheit.
    b. whole degrees Celsius.
    c. tenths of a degree Celsius.
    d. whole degrees Kelvin.

REVIEW QUESTIONS

7. If using Fahrenheit thermometers to obtain temperatures, the thermometers must be read to the nearest _____.

   a. tenth of a degree Fahrenheit.
   b. whole degree Fahrenheit.
   c. whole degree Celsius.
   d. tenth of a degree Celsius.

8. When computations require the disposal of decimals of negative numbers, and the decimal to be disposed of is five, the preceding digit will

   a. be increased by one.
   b. remain unchanged.
   c. remain unchanged if that digit is even.
   d. remain unchanged if that digit is odd.

9. A temperature of 4^0C and a dewpoint of 2^0C below zero is entered in columns 11 and 12 (temperature and dewpoint) of MF1M-10C as

   a. 04/M02
   b. 4/M2
   c. 4/-2
   d. 04/-02

10. A dry-bulb temperature of 0.5^0C is recorded in column 11 of the MF1M-10C as

    a. 00
    b. 01
    c. 05
    d. 10

11. How is a dry-bulb temperature of 25.5^0C below zero reported in a coded *transmitted* aviation weather report?

    a. –25
    b. –26
    c. M25
    d. M26

12. The dew point is always reported with respect to

    a. water at temperatures below 32^0F, and ice above 32^0F.
    b. ice.
    c. water.
    d. ice at temperatures below 32^0F, and water at temperatures above 32^0F.

13. If fog is not present and the wick of your wet bulb thermometer is covered with ice but you are unable to get a depression, how should the dew point be reported?

    a. omit
    b. us the same value as the temperature
    c. convert the dry bulb reading from respect to ice to respect to water
    d. estimated based on the last observation